Remarks

Claims 6-9, 11-16, 18, 19, 26-29, 32-37, and 47-50 are pending the present application. By this Amendment, claim 27 has been amended to correct a typographical error, and new claims 47-50 have been added. Reconsideration in view of the requested amendments and the following remarks is requested.

I. Rejection of Claims 6-9, 11-16, 18, 19, 26-29 and 32-37

Claims 6-9, 11-16, 18, 19, 26-29 and 32-37 were rejected as allegedly being obvious from U.S. Patent No. 6,267,125 to Bergman et al. (Bergman) in view of U.S. Patent No. 5,929,324 to Hu et al. (Hu) and U.S. Patent No. 6,406,551 to Nelson et al. (Nelson). Applicants traverse this rejection and request that it be withdrawn.

A. Patentability of Claims 6-9

Claim 6 is directed to a method for semiconductor wafer fabrication. The method includes incorporating a reactant gas that is capable of reacting with a material on the surface of a wafer into a liquid solvent that is inert to the material on the surface of the wafer to provide a reactant mixture. The method also includes forming a film of the reactant mixture on the wafer surface so that the reactant gas is transported through the film to the wafer surface and reacts with the material thereon. The method further includes cooling the wafer to a temperature equal to or less than about a dew point of the liquid solvent to facilitate the formation of the film on the wafer surface. For at least the following reasons, claim 6 is not obvious from Bergman in view of Hu and Nelson.

To establish a *prima facie* case of obviousness, there must be some suggestion or motivation, either in the references or in the knowledge generally available to one of ordinary skill in the art, to modify a reference or to combine reference teachings. MPEP § 2143. However, there is no suggestion to combine or modify if a reference teaches away from making the specific combination of elements recited in a claim. *See Tec Air, Inc. v. Denso Mfg. Mich. Inc.*, 192 F.3d 1353, 1360, 52 U.S.P.Q. 2d 1294, 1298 (Fed. Cir. 1999); *In re Fine*, 837 F. 2d 1071 (Fed. Cir. 1988) (holding that the prior art contained no teaching or suggestion to substitute a nitric oxide detector of the secondary reference with the sulfur dioxide detector of the primary reference because the latter taught against detecting for the presence of nitrogen compounds).

"A reference may be said to teach away when a person of ordinary skill, upon reading the reference, would be . . . led in a direction divergent from the path that was taken by the Applicant . . . ." *Tec Air*, 192 F.3d at 1360. *See also In re Arbeit et al.*, 201 F.2d 923, 96 USPQ 397 (C.C.P.A. 1953) (finding the applicants' argument convincing that certain claims were patentable because the primary emphasis of the prior art reference was "diametrically opposed" to the applicant's invention).

In the present case, Bergman teaches away from cooling a wafer to a temperature equal to or less than about a dew point of a liquid solvent, as recited in claim 6, in that the primary emphasis of Bergman concerns *heating* the workpiece to an elevated temperature to accelerate reaction kinetics at the surface of the workpiece. For example, Bergman states that in "a preferred method for treating a workpiece, the workpiece is first heated." (emphasis added) See Bergman, col. 3, lines 13-14.

In another passage, referring to the system 120 shown in FIG. 2, Bergman states the following:

> The system 120 of FIG. 2 is based upon the recognition by the present inventors that the heating of the surfaces of the semiconductor workpieces 20 with a heated liquid that is supplied along with a flow of ozone that creates a ozonated atmosphere is highly effective in photoresist stripping, ash removal, and/or cleaning processes. As such, system 120 includes one or more heaters 125 that are used to heat the treatment liquid so that it is supplied to the surfaces of the semiconductor workpieces at an elevated temperature that accelerates the surface reactions. It will be recognized that it is also possible to directly heat the workpieces so as to stimulate the reactions. Such heating may take place in addition to or instead of the indirect heating of the workpieces through contact with the heated treatment liquid. For example, supports 25 may include heating elements that may be used to heat the workpieces 20. The chamber may include a heater for elevating the temperature of the chamber environment and workpieces.

(emphasis added) See Bergman, col. 5, lines 8-25.

FIG. 6 of Bergman illustrates an embodiment that includes an ultra-violet lamp 300 for irradiating the surface of the semiconductor workpiece 20 during processing. Bergman explains that "[s]uch irradiation further enhances the reaction [kinetics]." See Bergman, col. 7, lines 10-15.

These passages of Bergman unequivocally advocate the importance of enhancing reaction kinetics during processing through heating a workpiece and that optimum results are achieved at elevated surface temperatures. Not only does Bergman fail to teach or suggest cooling a wafer,

Bergman's teachings concerning heating a workpiece are diametrically opposed to the method recited in claim 6. Further, heating a workpiece cannot yield a temperature equal to or less than a dew point of a liquid solvent, as recited in claim 6. Therefore, Bergman actually teaches against modifying the method described in this reference to include the act of cooling a wafer, as required in claim 6.

Nelson and Hu do not make up for the deficiencies of Bergman. More specifically, Nelson, like Bergman, describes a method for stripping photoresist from a semiconductor wafer that involves heating a wafer to enhance reaction kinetics. For example, Nelson states:

> Generally, the method involves contacting the substrate(s) with a heated liquid in a manner effective to heat at least a portion of the substrate and further contacting the substrate(s) with a processing liquid that comprises a heat sensitive agent. Because the substrate is heated, an enhanced treatment rate of the substrate can be achieved.

(emphasis added) Nelson, col. 4, lines 12-17.

In describing the importance of heating the substrate, Nelson explains that the "utilization of a heated liquid to heat a substrate while either simultaneously, sequentially or intermittently treating the substrate with a processing liquid . . . has a number of positive effects on several other parameters that, in turn, effect the treatment rate or the quality of treatment." Nelson, col. 4, lines 45-50. Hence, Nelson, like Bergman, teaches that it is necessary to heat a wafer to achieve enhanced treatment effectiveness and flies in the face of cooling a wafer to a temperature equal to or less than a dew point of a liquid solvent, as recited in claim 6.

Hu concerns an apparatus that is used to detect gas leakage from a gas reactor, such as an ozone generator. In the "Background of the Invention" section, Hu describes a conventional cleaning process in which wafers are cleaned with water injected with ozone. Hu, col. 1, lines 43-46. Hu mentions that this process can be carried out at room temperature. Hu, col. 1, lines 60-61.

In contrast to claim 6, Hu provides no teaching or suggestion for cooling a wafer to a temperature equal to or less than a dew point of the liquid solvent while cleaning the wafer of photoresist. In fact, cooling of the wafer likely would not be involved if the process is carried out at room temperature. Applicants also note that "room temperature" is not necessarily the dew point of a liquid. Thus, no combination of Bergman, Nelson, and Hu would provide the specific combination of features recited in claim 6.

Furthermore, MPEP § 2145 (X)(D)(2) states that "It is improper to combine references where the references teach away from their combination." In the present case, Hu teaches away from Bergman and Nelson because both Bergman and Nelson teach heating a wafer to enhance treatment effectiveness while Hu teaches cleaning a wafer at room temperature. Thus, Hu cannot be properly combined with Bergman and Hu in the manner suggested by the Examiner.

Additionally, MPEP § 2143.01 states that references cannot be combined if the proposed modification would render the prior art device unsatisfactory for its intended purpose. If one were to carry out the Bergman method at room temperature, as suggested by the Examiner (i.e., without heating the wafer under treatment, either by a heated treatment liquid or heaters inside the treatment chamber), the process would fail to achieve its intended purpose, i.e., to promote the reaction kinetics of ozone on the surface of the wafer. See, e.g., Bergman, col. 5, lines 13-25 and col. 6, lines 38-43. For this additional reason, Hu cannot be properly combined with Bergman in the manner suggested by the Examiner.

Finally, the Examiner contends that the disclosures of Bergman, Nelson, and Hu would "enable one of ordinary skill in the art to be led to the recited temperature range including cooling if desired to achieve a desired effectiveness of the photoresist stripping process." This contention is not only unclear, but also it suggests that the standard being applied to support the obviousness rejection is whether the prior art references would eventually lead one skilled in the art to derive the claimed method. This is not the proper standard for obviousness. As discussed above, the proper standard for determining obviousness is whether the prior art references suggest the desirability of combining elements form the references to derive the invention. *In re Dow Chemical Co.*, 837 F.2d 469, 473 (Fed. Cir. 1988) (holding that an "obvious to experiment" standard does not support an obviousness rejection under 35 U.S.C. § 103(a)). In the present case, none of the references explains why it would be desirable to cool a wafer to a temperature equal to or less than the dew point of a liquid solvent, as recited in claim 6. Moreover, as discussed above, the references considered as a whole would have led one skilled in the art to heat a wafer during processing to improve stripping effectiveness, as emphasized by Bergman and Nelson.

Accordingly, for at least the foregoing reasons, claim 6 is not obvious from any combination of Bergman, Nelson, and Hu, and the rejection of claim 6 should be withdrawn.

Dependent claims 7-9 depend from claim 6 and therefore are allowable for the reasons given above in support of claim 6 and further because each dependent claim sets forth an independently patentable combination of features.

B. Patentability of Claims 11-13

Claim 11 is allowable because there is no disclosure in Bergman, Nelson, or Hu that teaches or suggests condensing a liquid solvent onto a surface of a wafer, as recited in claim 11. FIGS. 1-4 and 6 of Bergman disclose spraying water (in liquid form) through nozzles 40 into a chamber to form a liquid layer on a workpiece. Because the water is not vaporized, it is not later condensed on a surface, as recited in claim 11.

With regard to the embodiment shown in FIG. 5 of Bergman, which includes a steam generator for supplying saturated steam to the process chamber, there is no indication that a liquid layer is formed on the surface of the workpiece in the chamber. A workpiece merely being present in a steam environment does not necessarily result in formation of a liquid layer on the surface of the workpiece. Condensing a vapor (such as steam) can be achieved by either increasing the pressure and/or decreasing the temperature, e.g., cooling the wafer. There is no teaching or suggestion in Bergman to increase the pressure within the chamber or to cool the workpiece so as to form a liquid layer on the surface of the workpiece. Further, as discussed above, Bergman actually teaches away from forming such a layer by specifically teaching *heating* the workpiece.

Nelson and Hu do not make up for the deficiencies of Bergman. In particular, Nelson discloses a processor 10 that includes a spray post 20 for spraying a processing liquid 42 onto a plurality of wafers 19. Nelson, col. 9, lines 36-57 and FIGS. 1 and 2. Hu, as discussed above, merely describes a conventional cleaning process in which wafers are cleaned with water injected with ozone. Nelson and Hu, like Bergman, provide no teaching or suggestion for condensing a liquid solvent onto a surface of a wafer, as recited in claim 11

Accordingly, for at least the foregoing reasons, claim 11 is not obvious from any combination of Bergman, Nelson, and Hu, and the rejection of claim 11 should be withdrawn.

Dependent claims 12 and 13 depend from claim 11 and therefore are allowable for the reasons given above in support of claim 11 and further because each dependent claim sets forth an independently patentable combination of features.

C. Patentability of Claims 14 and 15

Claim 14 recites a method for semiconductor wafer fabrication that includes vaporizing a liquid solvent that is inert to a material on a surface of a wafer, incorporating a reactant into the vaporized solvent, and condensing the vaporized solvent incorporating the reactant gas to form a film on the wafer surface.

Claim 14 is properly allowable over any combination of Bergman, Nelson, and Hu because none of these references provides any teaching or suggestion of condensing a vaporized solvent onto a surface of a wafer, as recited in claim 14.

Dependent claim 15 depends from claim 14 and therefore is allowable for the reasons given above in support of claim 14 and further because claim 15 sets forth an independently patentable combination of features.

D. Patentability of Claims 16-19

Claim 16 recites a method for semiconductor wafer fabrication comprising forming a film of a liquid solvent on the surface of a wafer, exposing the film to a reactant gas so that the gas is transported through the film to the wafer surface, and cooling the wafer to a temperature equal to or less than about a dew point of the liquid solvent.

As discussed above with respect to claim 6, neither Bergman, Nelson, nor Hu (either alone or in combination) teaches or suggests cooling a wafer under treatment. Thus, and for the additional reasons discussed above regarding claim 6, claim 16 is properly allowable over any combination of Bergman, Nelson, and Hu.

Dependent claims 17-19 depend from claim 16 and therefore are allowable for the reasons given above in support of claim 16 and further because each dependent claim sets forth an independently patentable combination of features.

E. Patentability of Claims 26-29

Claim 26 recites a method of semiconductor fabrication comprising selecting a liquid solvent that is inert to a material on a surface of a wafer, selecting a reactant gas that is capable of chemically reacting with the material on the wafer surface, and incorporating the reactant gas into the liquid solvent. Claim 26 also requires showering the liquid solvent incorporating the reactant gas onto the wafer surface and controlling the temperature at or near the surface of the wafer so that the temperature at or near the wafer is less than the temperature of the showering liquid solvent.

As discussed above, Bergman and Nelson teach heating a wafer to enhance treatment effectiveness, and therefore teach away from controlling the temperature at or near the surface of a wafer to be less than the temperature of a showering liquid solvent. The fact that the teachings of Bergman and Nelson run counter to the instantly claimed method actually supports, rather than negates, patentability of claim 26.

Hu does not make up for the deficiencies of Bergman and Nelson. Hu describes a conventional wafer-cleaning process that can be carried out at room temperature. In contrast to claim 26, Hu provides no teaching or suggestion for controlling the temperature at or near the surface of a wafer to be less than the temperature of a liquid solvent applied to the wafer. Thus, no combination of Bergman, Nelson, and Hu would provide the specific combination of features recited in claim 26.

In any event, Hu cannot be properly combined with Bergman and/or Nelson because Bergman and Nelson teach away from Hu in that Bergman/Nelson teach heating a wafer to enhance treatment effectiveness while Hu teaches cleaning a wafer at room temperature. Additionally, if one were to carry out the Bergman method at room temperature, as suggested by the Examiner (i.e., without heating the wafer under treatment, either by a heated treatment liquid or heaters inside the treatment chamber), the process would fail to achieve its intended purpose, i.e., to promote the reaction kinetics of ozone on the surface of the wafer. See, e.g., Bergman, col. 5, lines 13-25 and col. 6, lines 38-43. For this additional reason, Hu cannot be properly combined with Bergman in the manner suggested by the Examiner.

Accordingly, for at least the foregoing reasons, claim 26 is not obvious from any combination of Bergman, Nelson, and Hu, and the rejection of claim 26 should be withdrawn.

Dependent claims 27-29 depend from claim 26 and therefore are allowable for the reasons given above in support of claim 26 and further because each dependent claim sets forth an independently patentable combination of features.

F. Patentability of Claims 32-36

Claim 32 recites a method for removing photoresist material from a semiconductor wafer. The method includes cooling the wafer, forming a layer of liquid on a surface of the wafer, and introducing ozone gas over the liquid layer such that some of ozone gas is transported through the liquid layer to the wafer surface.

As discussed above with respect to claim 6, neither Bergman, Nelson, nor Hu (either alone or in combination) teaches or suggests cooling a wafer under treatment. Thus, and for the additional reasons discussed above regarding claim 6, claim 32 is properly allowable over any combination of Bergman, Nelson, and Hu.

Dependent claims 33-36 depend from claim 32 and therefore are allowable for the reasons given above in support of claim 32 and further because each dependent claim sets forth an independently patentable combination of features.

G. Patentability of Claim 37

Claim 37 recites a method for removing photoresist material from a semiconductor wafer. The method includes vaporizing a mixture of water and ozone gas and condensing a layer of the mixture on a surface of the wafer having photoresist material thereon.

As discussed above with respect to claim 11, neither Bergman, Nelson, nor Hu (either alone or in combination) teaches or suggests vaporizing a liquid and condensing the liquid on a wafer under treatment. Thus, claim 37 is properly allowable over any combination of Bergman, Nelson, and Hu.

II. Conclusion

The present application is in condition for allowance and such action is respectfully requested. If any further issues remain concerning this application, the Examiner is requested to call the undersigned to discuss such matters.

Respectfully submitted,

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